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Modern Trends in Service Test Equipment

PART II

By the Engineering Department, Aerovox Corporation

CHANNEL ANALYSIS AND CHANNEL ANALYZERS

Some mention was made in the opening paragraphs of this paper (September 1940 issue Aerovox Research Worker) concerning the checking of static characteristics — the simple checking of circuit continuity and measurement of voltages and currents—used for so many years by servicemen to locate defective circuits and components.

If voltage, current, and resistance measurements are made at each of the

many dozen connection points in a receiver, the trouble shooter may expect eventually to discover a burned-out or open-circuited component. The only essential instrument for this job is one of the meters previously described. However, such a test is purely one of static values, and even for this intended purpose is time-consuming. It will not always locate the intermittents that are so often encountered in radio receivers, nor will it reveal discrepancies in gain, bypassing, and coupling, or the action of bypass and coupling condensers, signal transfer,

localize hum and noise or detect defective tubes under actual operating conditions.

To provide these essential tests of a receiver under actual operating conditions, dynamic testing has largely supplanted static checking among the best experts. Each channel (r.f., i.f., oscillator, audio, etc.) is analyzed in operation, to detect the absence of the signal itself, or the signal quality.

Channel analysis is not new. Many early servicemen used various comparable methods to check the r.f. por-

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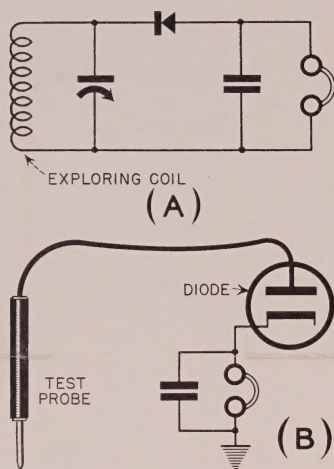


Fig. 7

tions of circuits after a static test had shown all operating voltages to be correct and continuity perfect in the total absence of a signal. Two of the devices commonly used some years ago are shown in Figure 7 (A and B). The first device is nothing more than a simple crystal receiver. Its tuning coil was a small "exploring" coil held near a stage coil in the receiver. If the receiver coil were in operation, its field would cause a current to be induced in the exploring coil and the operator would hear the signal. If continuity checked, the possibility would be, under these circumstances, that the tube was not operating. The second device, used by direct connection of a test probe to suspected points of inoperation, utilized a diode tube rectifier and could be used in audio and power a.c. circuits as well as r.f. stages.

Both of these devices were popularly known as "signal chasers" or "signal tracers" and the system of such dynamic analysis or channel testing called "signal tracing".

The channel analyzers in vogue at present are highly-developed versions of these early signal tracers. It is the scheme in the modern complicated instrument to supply a nicely designed channel in replacement of any stage in the receiver and at the end of this channel to notice the presence of the signal, its magnitude and quality or its absence entirely.

The channel analyzer is shown (in functional block diagram of the prominent channels it supplies) in Figure 8. The separate channels shown in the diagrams are usually arranged at will within the channel analyzer through switching operations performed from the front of the instrument, or through the insertion of the test probes into designated input jacks.

It will be observed from Figure 8A that a 3-stage tuned amplifier, linear detector, and indicating device (which may be a magic eye tube or a built-in version of the electronic d.c. voltmeter previously described) are supplied by the analyzer for r.f. and i.f. checking. The amplifier and detector stages are tunable over the useful range of short-wave and broadcast and intermediate frequencies. In operation, a signal (from local oscillator or outside station) is applied to the input terminals of the receiver stage under test; and, starting at the input terminals themselves, the analyzer test probes are touched to various points, progressing to the output terminals of the stage, to detect the presence, absence, or magnitude of the signal. For r.f. and i.f. testing, one of the analyzer probes is provided with a built-in 1 mmfd. fixed condenser to isolate analyzer and operator from the circuit under test.

The oscillator testing channel (Figure 8B) includes one tuned amplifier stage which is tuned to the frequency of the receiver oscillator, a tuned linear detector stage; and, as above, an indicating device. Here again, a condenser isolated test probe with shielded cable is used for circuit explorations. In operation, the channel is tuned to the frequency of the receiver oscillator with the isolated test probe touched to the oscillator output terminal. The indicating instrument will then show the presence and extent of oscillation.

The audio-frequency channel (Figure 8C) is comprised of a calibrated input attenuator, a single-stage resistance-coupled amplifier, a diode rectifier, and an indicating device. The input terminals are connected to the various "signal points" in the audio amplifier with a signal applied to the latter's input from an audio oscillator or radio receiver.

There are numerous types of channel analyzers in use at present, but all employ the fundamental channel substitution scheme described in the foregoing. They provide speed and certainty in the localization of trouble often undetectable at all by other

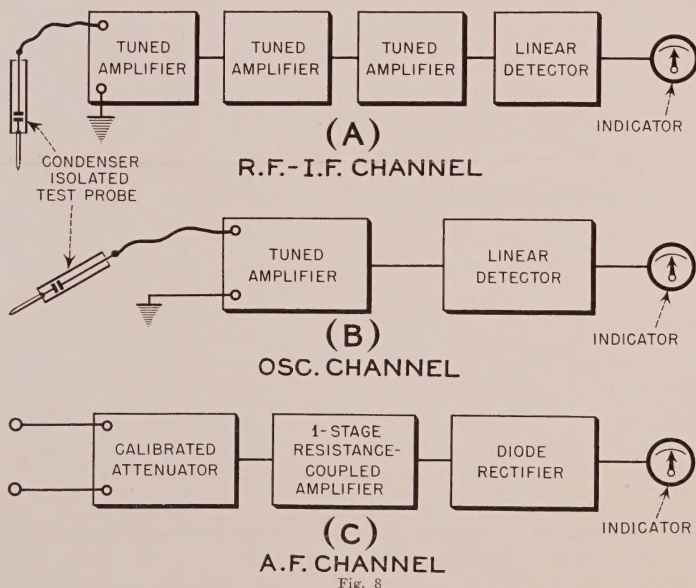


Fig. 8



methods, and afford the very desirable advantage of checking under actual dynamic operating conditions. While the channel analysis technique has completely supplanted static testing in preliminary diagnosis, the latter method is often necessary for final discovery of a defective component after the trouble has been localized to one particular stage by signal tracing.

P.A. CHANNEL ANALYSIS

The apparatus shown in the diagram in Figure 8C may be further elaborated to include a battery of switched power load resistors to replace the output windings of loudspeakers, a fixed-frequency audio oscillator with controllable, calibrated output between 1 millivolt and several volts, and a power output meter. The instrument obtained thereby would be a complete analyzer for the dynamic testing of public address amplifiers, modulators, and similar audio systems. Indeed, at least one such audio channel analyzer has been offered commercially by RCA.

TEST OSCILLATOR ADVANCES

Service test oscillators have recently undergone such improvements which bring them nearer to the level of the laboratory signal generator. This has probably been due to the more rigorous demands made upon these devices by the adoption of all-wave receivers and general improvement of receiver selectivity. While there are still available a number of oscillators in the unimproved category, a goodly number of other instruments have been materially refined as regards frequency stability, accuracy of calibration, effectiveness of attenuation, purity of r.f. and modulating waveforms, and indication of fractional voltage output.

An arrangement typical of these advances is shown diagrammatically in Figure 9. Such a combination permits the serviceman to determine the following receiver characteristics necessary to restore the set to the original factory condition: sensitivity, overall and per-stage selectivity, signal-to-image and signal-to-noise ratios, overall fidelity, overall and per-stage gain, and frequency alignment.

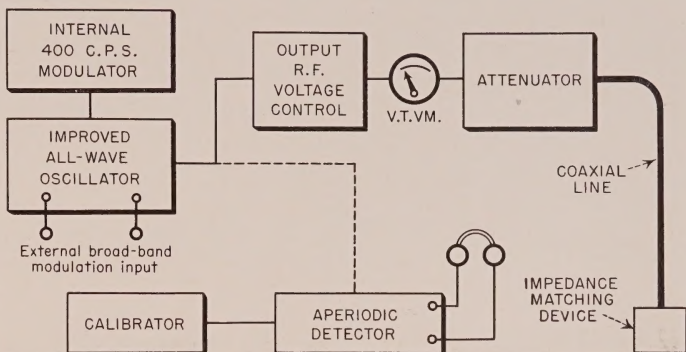


Fig. 9

In the more advanced of the recently-developed service oscillators, an improved all-wave oscillator circuit proper (tuning from about 100 kc. into the ultra-high frequency region) is followed by a voltage output control, a vacuum-tube voltmeter, and a shielded attenuator (Figure 9). When the oscillator output voltage is adjusted, by means of the voltage control, to exactly 1 volt r.f., the panel calibration of the attenuator is correct, the actual instrument output being indicated in microvolts.

As an additional advantage some of the new oscillators are provided with internal calibrators or connections for external calibration oscillators. As shown in Figure 9, an aperiodic heterodyne detector (with headphones or magic eye indicator) may be connected after the oscillator to receive the oscillator signal together with a signal from a 100 kc. calibrator. With this arrangement, numerous points on the test oscillator dial may be checked from time to time by the harmonic beat note method.

The new test oscillators utilize coaxial cables for connection to external frequency circuits, in one case having impedance-matching devices at the cable termination.

In one new model, input is provided for broad band modulation, enabling square-wave and picture signal modulation for television receiver testing, as well as the more familiar 20-15,000-cycle audio modulation. External connections are also provided for any of the electronic frequency modulators (wobblers) for oscilloscopic selectivity curve tracing.

In the newer test oscillators, the electron-coupled circuit, so long a favorite, has been almost totally abandoned. In its place are found plate-tuned, grid-tuned, and Colpitts circuits which are made extremely stable by means of plate resistor methods and voltage regulation of the plate power supply. These latter circuits, possessing notably less harmonic distortion than the electron-coupled arrangement, afford better r.f. waveform.

VARIABLE-FREQUENCY AUDIO OSCILLATORS

The greatest single improvement in continuous-coverage audio oscillators available to the trade has been the incorporation of the resistance-tuned circuit which is rapidly supplanting the old beat-frequency oscillator in service applications. Extremely simple in theory and construction, the resistance-tuned circuit possesses amazing stability, provides an instrument that needs no periodic resetting to zero, and produces low-harmonic output voltage. The practical application of push-button frequency selection for rapid audio checking has been made possible by the resistance-tuned circuit.

Basically, the circuit is that of an audio amplifier with controllable degenerative feedback, enough regenerative coupling being provided to make the system self-oscillating. The frequency of oscillation is determined by a resistance-capacitance network of the same pattern as the classical Wien bridge and calculated in the same fashion.

Fluorescent-Lamp

POWER-
FACTOR Correction

CAPACITORS

- Power-factor correction is essential to the economical operation of fluorescent lamps on A.C. Otherwise, current consumption will greatly exceed the wattage rating of the fluorescent lamps used. Also, the existing wiring, while adequate for the former incandescent lamp load, may be seriously overloaded with fluorescent lamps of the same total wattage. Hence power-factor correction, and these new Aerovox Fluorescent-Lamp Capacitors for that very purpose.

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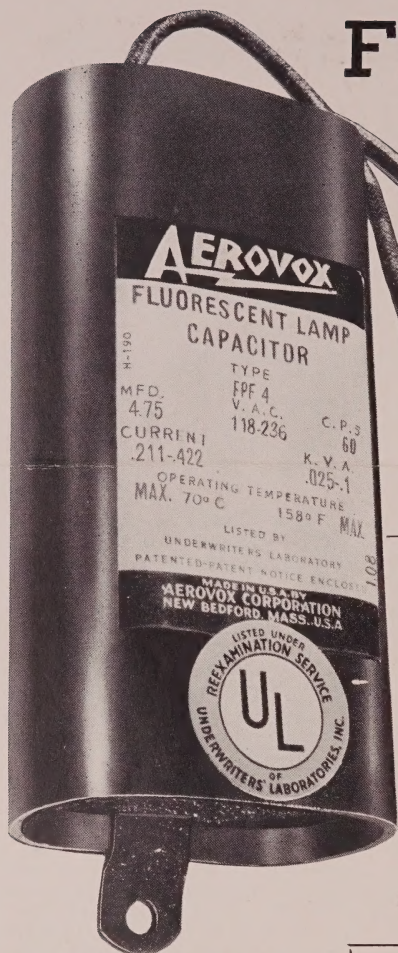
Lamp Type	Volts	No. Lamps Without Capacitors	No. of Lamps With Capacitors Added For Correction To		
			90%	85%	80%
15-T-8	118	45	88	83	78
15-T-12	118	41	85	80	75
20-T-8	118	42	67	64	60
30-T-8	118	23	43	40	38
40-T-12	118	20	32	30	29
30-T-8	236	45	76	71	67
40-T-12	236	35	57	54	51

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Cat. No.	Cap. in Mfds.	Nominal Volts A.C.	Size			Mtg. Center	Lead Length	List Price Each
			H	W	L			
FPF 4	4.75	118/236	1 1/4	2 1/4	5 1/2	5"	15"	\$1.35
FPF 6	6.5	118	1 1/4	2 1/4	5 1/2	5"	15"	1.45
FPF 11	11	118	1 1/4	2 1/4	6 1/8	6 1/8"	15"	2.30
FPF 17	17.5	118/236	1 1/4	2 1/4	14 1/8	14 1/8"	15"	3.35
FPF 28	28	118	1 1/4	2 1/4	14 1/8	14 1/8"	15"	3.85

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